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ABSTRACT

Two current instructional research efforts relating to the problem of an individual student's learning and personal needs are reported. Characteristics of individualized instruction (e.g., terminal course objectives, remedial materials, measurement procedures), administrative constraints (e.g., fixed time, cost of equipment, lack of skilled instructors), training strategies and goals are discussed. The APSTRAT (Aptitude Strategies) research involves peer instruction and provides for self-pacing, rapid feedback, and practice. Project IMPACT is an effort to provide the U.S. Army with an effective, efficient, and economical computer-administered instructional system. (Author)

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Individualized Training and the Training of Individuals

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Prefatory Note

This paper is based on research in training and educational technology conducted since 1951 by the Human Resources Research Organization. Two current research efforts are emphasized: Project IMPACT, Prototypes of Computerized Training for Army Personnel, conducted by HumRRO Division No. 1 (System Operations), at Alexandria, Virginia; and Work Unit APSTRAT, Training Strategies and Incentives Appropriate to Different Aptitude Levels for Selected Army Training Courses, conducted by HumRRO Division No. 3, at Presidio of Monterey, California.

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INDIVIDUALIZED TRAINING AND THE TRAINING OF INDIVIDUALS

William A. McClelland

INTRODUCTION

Industrial organizations, the military services, and civilian schools have long struggled with the great variety of instructional and administrative problems that attend the training and education of individuals. Small wonder that psychologists and educators have devoted attention to the classroom instructor's simple question, "But I have a class of 30 students: how *can* I attend to each individual student's learning and personal needs?"

It seems that psychology with a history of twentieth-century endeavors in the areas of human variation and learning should be able to answer the instructor's plaintive question. Inspection of contemporary educational psychology textbooks shows that the topic of human variability and its relation to learning is treated extensively. Yet, aside from certain limited studies, there is a paucity of data on how to individualize instruction. Why is this the case? In this paper, I shall look at the problem more closely and report on two current instructional research efforts that bear upon it.

Individualized Instruction—A Failure of Expectations?

What is meant by the term "individualization of instruction"? Historically it has, in practice, included two components: the rate at which a student passed through a course of instruction, and the assignment of remedial learning tasks to those students who did not achieve mastery (Baker, 1971). I offer an expanded definition. Ideally, individualized instruction should have these characteristics:

(1) Content designed to promote mastery of carefully defined terminal course objectives (which in training contexts are job-relevant). (This should be a characteristic of all instruction.)
(2) Adaptiveness to the individual capabilities and other characteristics that the trainee brings to the instructional setting.
(3) Provision for alternate instructional input and behavioral output modes.
(4) Alternate remedial instructional materials.
(5) Measurement procedures sensitive to the assessment of change in amount and kind of content mastery.

While no existing instructional system has all these characteristics, they are a set of bench marks for evaluation of individualized programs.

Philosophically, all instruction is individualized to some degree. There is a real question that completely individualized instruction can be achieved considering the current state of the art. Various contributors (Travers, Glaser, Carroll, and Jenkins) to Gagne's excellent book, *Learning and Individual Differences*, 1967, have indicated the primitive state of our knowledge. Baker (1971) states that progress in the areas of defining individualization, improved curriculum, diagnostic and prescriptive techniques, and an adequate conceptualization of the teacher as manager of the enterprise "is not readily achieved, and even small gains require a great investment in time, talent, and

funds." McFann (1969) says truly individualized instruction has not been achieved in research or practice, to his knowledge, and . . . "further, I am not sure it can be done."

Why hasn't more been accomplished by trainers, educators, and psychologists in this admittedly important instructional area? Two general answers come to mind—first, lack of research-based information of a kind that can be meaningfully applied in instructional settings, and, second, a great variety of administrative constraints.

In commenting on the uneven value of research on individual differences and learning, Cronbach (1967) points out that in laboratory studies of learning the stimuli remain the same from trial to trial. In classroom instruction, however, the stimulus material develops progressively and has a meaningful structure, thus making possible feedback without external prompting. Similarly, Seidel (1971) points out that learning theory has traditionally dealt with the micro-unit in the search for descriptive laws of behavior change. On the other hand, instructional research has concentrated on the macro-unit toward the development of better instructional strategies to serve prescriptive educational goals.

There are, of course, some severe administrative constraints with which we must deal in order to achieve individualization of instruction. In the area of training, for example:

- Fixed time for instruction, that is, only so much time can be allotted to achieving proficiency.
- Lack of skilled, professional instructors, as is so often the case in training situations.
- Inflexible features in the assignment process. In mass training systems, it takes time to determine training quotas, process and train students, and move graduates to the requesting field agencies.
- The cost of training equipment, facilities, instructors, and personnel to develop training materials.

Small wonder that the administrators of training systems appear to place concerns over how schedules are met, how output can be maintained, and generally how things are done administratively, above concerns for the teaching-learning process, and above the goal of producing trainee competence.

THE GOALS OF TRAINING

The goal in large-scale, individual training programs is to so allocate instructional resources—that is, men, methods, and materials—and so conduct training that the skills, knowledges, and attitudes required in a real-world, operating system can be attained. The result of the training should be both improved performance of the system for which the training was designed and an increased sense of personal worth by the individual performers. Ways must be found to eliminate or work within administrative constraints, so that an acceptable cost/benefit ratio is attained.

One aspect of training and educational technology, perhaps the keystone in this instructional arch, is the role of relevant training objectives. What must the trainee be able to do, to what level of proficiency, in what kind of work environment, supported by what job aids, tools, and equipment? For more than 30 years, educational leaders in the United States such as Ralph Tyler have been articulate spokesmen for the need for clearly stated educational objectives. Yet only in the last 10 years or so has there been much acceptance and implementation of the concept. Technical training curriculum research by HumRRO beginning in the mid 1950ties (Crawford, 1962; Smith, 1964; Ammerman and Melching, 1966) and the advent of programed instruction, however, made operational many of the facets of behavioral objectives in training. The role of behavioral objectives is, of course, also critical in the recent American emphasis on

accountability in education. Appropriately stated, job-relevant, performance-oriented behavioral objectives are a *sine qua non* in any training.

TRAINING STRATEGIES AND THE FACILITATION OF INDIVIDUALIZED TRAINING

There have been enunciated in recent years a set of options as to how education and training can be adapted to individual differences. Smith (1968) described five different aspects of individualization of instruction: by rate, that is, letting each student set his own pace; by remedial work, by satisfying requirements through proficiency tests, by tailoring objectives to the students, and by varying instructional methods and media.

Cronbach's (1967) formulation contains three basic strategies. If educational goals and instructional treatments are both fixed, use either sequential selection to alter the duration of schooling or train to a criterion on each skill or topic. Second, if educational goals provide the student with options and the instructional treatments remain fixed for each option, then prepare a curriculum that fits each for his prospective role. Finally, if educational goals are fixed within a course but alternative instructional treatments are provided, then one could provide remedial programs as adjuncts to be fixed, "main track" instruction or teach different pupils by different methods, or both.

A subsequent modification of Cronbach's schema by McFann (1969) has greater training relevance. He outlines four strategies:

(1) Fixed curriculum, fixed training time, and variable standard. While it is attractive to the administrator, the strategy patently ignores the fact of individual differences. Something has to give, and what gives is the standard achieved by the students. Terminal performance is highly variable. I doubt that many of us could find a pure example of this strategy.

(2) Fixed curriculum, variable training time, and either a fixed or variable standard. While all students receive the same instruction, some may receive all or parts of it several times. Since the armed services are the users of their graduates, minimum standards are established for graduation. In such instances, the standards tend to be fixed. This strategy makes only minimal allowance for individual differences through recycling or putting the student through the course or portion thereof once again.

(3) Variable curriculum, fixed training time, and a variable standard. This strategy does allow for human variability by varying the amount to be mastered (and perhaps its nature) in a fixed training time. More apt students can proceed more rapidly and learn more. Thus, the standards achieved above a minimal level are variable.

(4) Variable curriculum and variable training time that can result in either a fixed or variable standard. This strategy provides the most flexibility and naturally is the most difficult to administer.

It can be seen that the strategy selected will have a tremendous effect on the men, methods, and materials required for the successful conduct of the teaching-learning process. But, regardless of strategy, there must be both explicit terminal course objectives and explicit enabling objectives, the mastery of which is essential to achieving the terminal objectives. And, there must also be a comprehensive, continuing evaluation or quality procedure to assure that each student masters the specified objectives. Only then do we concern ourselves with the development of instruction and with the methods and media to be used in achieving the course objectives (McClelland, 1960; Crawford, 1962; Smith, 1966).

TWO HumRRO APPROACHES TO THE INDIVIDUALIZATION OF TRAINING

The Human Resources Research Organization (HumRRO) has been engaged in an active and comprehensive research and development program in training and educational technology since 1951. With a staff of about 250, HumRRO may well be the largest organization devoted to training research. We are now engaged in projects for a score of different clients, most of them federal, state, or local government agencies, with the U.S. Army sponsoring a major part of our work. The published results of these efforts appear primarily in our own reporting series. Two HumRRO studies currently in progress are especially pertinent to individualization of instruction.

Project IMPACT, Prototypes of Computerized Training for Army Personnel, is an effort designed to provide the U.S. Army with an effective, efficient, and economical computer-administered instruction (CAI) system (Seidel, 1969). Two successive generations of prototype CAI systems with prototype, multi-path individualized programs of instruction are under development and test. Instruction is directly relevant to specific military job requirements and, more importantly, it is adaptable to the student's personal and ability characteristics, as well as to his learning efforts during the course.

Development activities are proceeding concurrently in four areas; hardware, software, instructional content, and an instructional decision model. The latter is the heart of the project in that it comprises the algorithms, strategies, and rules that permit adaptation of the content to the learning needs of the individual student. By design and necessity, therefore, the IMPACT approach is multidisciplinary, involving the expertise of psychologists, mathematicians, engineers, programmers, technical writers, and course-content experts.

Unlike any other CAI development known to me, IMPACT is an *instructional system* a system in which the role of computer hardware, software, and mathematics is to implement the instructional process. An article reviewing CAI (*Educational Technology*, April 1969) cited this project as "the most thorough, well articulated, and integrated theoretical view for a CAI system and for learning CAI." While the research program is primarily supported by the Army, the National Science Foundation and the James McKeen Cattell Fund awarded grants to HumRRO in support of the development of the instructional decision model.

Work began on this effort three years ago. The products achieved to date in the first generation system include:

(1) Twelve functioning student stations that house the computer terminals and associated equipment. Included in these stations are cathode ray tubes for visual presentation of information and instruction, input typewriters, projection devices, and other audio-visual media.

(2) The preliminary version of an Instructional Decision Model, programmed for computer implementation.

(3) A provisional COBOL course that has been administered to several groups of students. It incorporates the preliminary version of the Instructional Decision Model.

(4) Interface equipment by which a number of auxiliary presentation devices can be used in conjunction with the cathode ray tube and the film projector for presentation of information and instruction to the student.

(5) The preliminary operating version of a speech recognition system that will allow the student to respond by voice to questions posed by the various presentation devices.

(6) Provision for student response, using an electronic pencil for making hand-printed characters.

(7) A set of preliminary specifications manuals for training Army instructional designers in CAI authoring techniques and for developing a hardware-software subsystem.

Will this effort produce a cost-effective, individualized instructional system? While we do not yet have the data to answer this crucial question, preliminary studies of the economics of CAI by Kopstein and Seidel (1967) and Alpert and Bitzer (1970) suggest CAI *is* economically feasible. We know computers can aid in instruction (Hollen *et al.*, 1968; Ford *et al.*, 1970; Homeyer, 1970); we know computers have the capacity to adapt to the needs of many students in a class. It would appear that we are most likely to move toward the goal of truly individualized instruction through such an approach as IMPACT.

Suppose, however, the physical resources required for CAI simply cannot be realized? Such an assumption was made in a second HumRRO effort (Weingarten *et al.*, 1970), sponsored by the U.S. Army and called APSTRAT, Training Strategies and Incentives Appropriate to Different Aptitude Levels for Selected Army Training Courses.

The purpose of APSTRAT is to develop a complete low-cost, performance-oriented training model, the application of which is capable of providing effective instruction in a wide variety of tasks for large numbers of trainees who are diverse in previous education and measured aptitude and who vary in their motivation to learn. The model had to meet these requirements; provide active learning of relevant performance in a functional or use context with rapid and detailed feedback to the learner, and also allow for pacing instruction to individual student needs on the basis of mastery of each step in an instructional sequence.

The model also accepted these operational constraints; no *additional* requirements for instructor personnel over those of the conventional program, no increase in course length, no additional equipment requirements, and no costly instructional hardware or software. IMPACT and APSTRAT differ markedly on several of these constraints.

Clearly, live instructors represent the most readily available instructional medium. Since they are too few, however, the decision was made to use trainees themselves as instructors. *Peer instruction is central to the APSTRAT model.*

The course selected for study was the U.S. Army's Field Wireman Course (MOS 36K), which involves laying wire, installing and operating switchboards, and receiving and distributing messages. It is organized around a series of job performance stations representing a rather broad variety of psychomotor and cognitive duties that a job incumbent must perform. Each trainee proceeds through a four-stage cycle of (a) observation of the job being performed, (b) skill acquisition, (c) job performance and mastery evaluation, and (d) teaching a peer to acquire requisite skills and knowledge. The cycle is repeated for each job performance station in the curriculum.

Initially the regular instructor's role was critical in course design and development. Operationally, he becomes a supervisor who maintains rigorous quality control via the mechanism of proficiency testing, as well as serving as a master teacher and diagnostician.

Peer instruction in the APSTRAT model permits a one-to-one student-instructor ratio and thus provides flexibility for self-pacing and rapid feedback both to the peer-instructor and to the student. The method offers certain advantages especially appropriate for trainees low on the educational and aptitude continua. Since trainees know they are learning from others who have just mastered these new skills, they may not feel as threatened by fear of failure or as afraid to show their ignorance. Extra motivation to learn is provided by the knowledge that soon the trainee will become the peer instructor. The peer instructor, on the other hand, gains the advantage of reviewing and practicing his newly acquired skills.

The data collected to date in both the experimental and Army field test phases show real improvements in trainee attitudes and motivation, as well as appreciable reductions in failure and recycle rates.

Since the APSTRAT model was developed and tested as an entire instructional system, two essential questions remain unanswered: "Why does it work?" and "Will it generalize to other courses?" We hope to get answers to the first question by a series of laboratory studies on the subelements of the model. Only when the model has been fully developed and tested in other courses will it be possible to answer the question of generality.

On the surface, these two HumRRO studies approach the individualization of training quite differently, and many of the differences arise from the constraints imposed. However, both are adaptive, although their precision in adapting to student needs varies, and the instructional rules and strategies inserted in the electronic computer vary from those in the peer instructor's brain or wet computer. With differential precision, both provide for different input and output channels in the instructional process. In both, limited remedial instructional materials are available. Both require carefully constructed training objectives and provide sensitive criteria-referenced mastery tests. The content most appropriate for each approach is yet to be determined. Of course, IMPACT and APSTRAT are only two instructional models; many others are possible.

SUMMARY AND CONCLUSIONS

In this paper I have discussed briefly the problems of adapting training to individual differences, commented on essential features of the technology of training that must be incorporated in individualized training, mentioned a number of common but undesirable—and also some uncommon but desirable—training strategies, and described two of HumRRO's instructional approaches to the challenge of individualized training. As applied psychologists, we are learning what kinds of training approaches appear to have the characteristic of adaptiveness to human variation. Thus we have taken the first halting, but essential, steps toward learning why these pragmatic programs work. Much remains to be discovered and understood. But perhaps from these and similar efforts will emerge better resolutions to the problem of adapting training effectively and efficiently to the individual student.

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